Ocean Color Data at the Goddard DAAC

CZCS, SeaWiFS, and MODIS

March 1999

SeaWiFS Chlorophyll, October 1998

The apparent color of the ocean is determined by the interactions of incident light with substances or particles present in the water. The most significant constituents are free-floating photosynthetic organisms (phytoplankton) and inorganic particulates. Phytoplankton contain chlorophyll, which absorbs light at blue and red wavelengths and transmits in the green. Particulate matter can reflect and absorb light, which reduces the clarity (light transmission) of the water. Substances dissolved in water can also affect its color.

Observations of ocean color from space, utilizing sensors specially designed to detect the small amount of light radiating from the sea surface, provide a global picture of the patterns of biological productivity in the world's oceans. For that reason, ocean color remote sensing data is a vital resource for biological oceanography. Unlike the limited area of the ocean that can be investigated from a research ship, data from a satellite sensor covers a large region and provides a comprehensive view of the marine environment.

The Goddard Distributed Active Archive Center (DAAC) is the designated archive for all of the ocean color data produced by NASA satellite missions. The DAAC is a long-term, high volume, secure repository for many different kinds of environmental data. With respect to ocean color, the Goddard DAAC holds all the data obtained during the eight-year mission of the Coastal Zone Color Scanner (CZCS). The DAAC is cur-

rently receiving data from the Sea-viewing Wide Field-of-view Sensor (SeaWiFS) Project, and will archive all of the Moderate Resolution Imaging Spectroradiometer (MODIS) Level 1 data, as well as the entire suite of MODIS Ocean Level 2 and Level 3 geophysical products.

SeaWiFS HRPT of Baja California, January 26, 1998
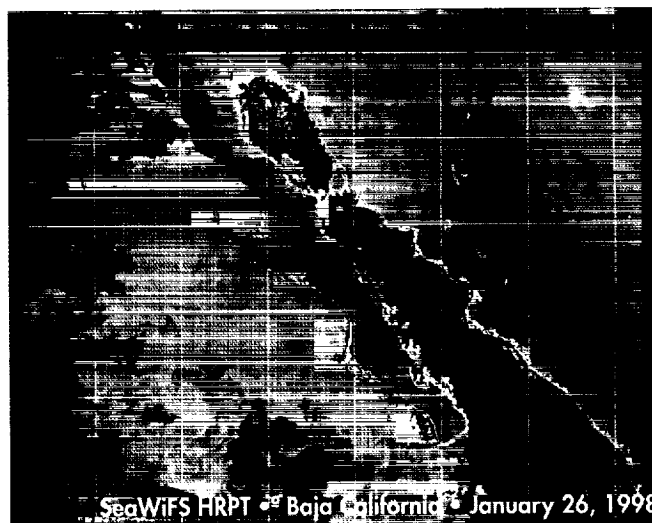
In addition to its archive and distribution services, the Goddard DAAC strives to improve data access, ease-of-use, and data applicability for a broad spectrum of customers. The DAAC's data support teams practice dual roles, both insuring the integrity of the DAAC data

archive and serving the user community with answers to user inquiries, online and print documentation, and customized data services.

Coastal Zone Color Scanner (CZCS)

The Coastal Zone Color Scanner (CZCS) was a conventional multi-channel scanning radiometer deployed on the NIMBUS-7 environmental satellite mission. CZCS operated from November 1978 to June 1986, and obtained more than 56,000 images of water-leaving radiances from the world's oceans, which were processed into images of phytoplankton pigment concentration. Four of the six CZCS spectral bands (or channels) were specifically for ocean color and had a 20nm bandwidth. Due to sharing of power with other NIMBUS-7 instruments, the CZCS was operated on an intermittent duty cycle, so that the dataset respresents only partial spatial and temporal coverage of the oceans. The eight-year mission of the CZCS represents the first instrumental remote-sensing observation of marine biological activity from space.

CZCS Browser: http://daac.gsfc.nasa.gov/CAMPAIGN_DOCS/BRS_SRVR/czcsbrs_main.html

The Goddard DAAC holds the entire archive of CZCS Level 1, Level 1A, and Level 2 scenes, as well as Level 3 monthly composite images. All of the CZCS scenes can be ordered using the DAAC CZCS Data Browser, which formats data searches based on user-defined spatial and temporal search criteria and displays Level 2 browse images. Level 1 data are 1 km resolution in CRTT format, which may be processed to Level 2 using UNIX SEAPAK. Level 1A and Level 2, 4 km resolution, are available in DSP and HDF (the HDF data can be obtained directly by FTP). The Level 3 composites are in DSP format. All data can be obtained either by FTP or on tape (4mm DAT or 8mm EXABYTE cassettes). In addition, the DAAC Interdisciplinary Data Collection archive possesses 1°x1° resolution monthly CZCS global composite data in binary format. The DAAC also features World Wide Web educational resources, print documentation, and access to CZCS-related software.

Sea-viewing Wide Field-of-view Sensor (SeaWiFS)

The Sea-viewing Wide Field-of-view Sensor (SeaWiFS) builds on the heritage of the CZCS mission. SeaWiFS is a dedicated global imager, observing over 90% of the oceans every two days at a resolution of 4.5 kilometers. Local receiving stations can receive SeaWiFS data for extensive regions of the ocean at a resolution of 1 kilometer. With an improved signal-to-noise ratio, 10 nm bandwidth, and two additional bands, SeaWiFS data

allow improved atmospheric correction and more precise measurement of phytoplankton pigment and chlorophyll concentration. SeaWiFS data will, for the first time, permit measurement of chlorophyll concentration in both the crystalline blue-green waters of the open ocean and also the turbid green and brown waters found near the continental coasts. The global imagery obtained by SeaWiFS will provide marine scientists with a comprehensive and continuous view of the shifting mosaic of global ocean color.

SeaWiFS Browser: http://daac.gsfc.nasa.gov/CAMPAIGN_DOCS/BRS_SRVR/seawifsbrs_main.html

The Goddard DAAC is the archive of all SeaWiFS data products produced by the SeaWiFS Project. The archive includes Level 1A radiance data, Level 1A High Resolution Picture Transmission (HRPT) station data, Level 2 geophysical parameters, Level 3 binned data, and ancillary meteorological and ozone data. All of the data products are ordered using the SeaWiFS Data Browser, which searches the expanding archive according to user-defined spatial and temporal search criteria. Either Level 1A true-color or Level 2 chlorophyll concentration browse images are displayed for perusal and request. SeaWiFS data are available either by FTP or on 4mm DAT or 8mm EXABYTE tapes.

DAAC services for SeaWiFS data include data subscriptions and parameter subsetting. Data subscriptions allow automatic retrieval and delivery of user-specified data products (by FTP or on tape) as they are received from the SeaWiFS Project. Parameter subsetting allows users to select individual Level 3 binned geophysical parameters in lieu of an entire Level 3 binned data file. In addition to these services, the DAAC is responsible for insuring that access to SeaWiFS data for oceanographic research is restricted to SeaWiFS Authorized Users. (For information on how to become a SeaWiFS Authorized User, please contact the SeaWiFS Project.)

All volumes of the SeaWiFS Technical Report Series may be ordered through the DAAC. The DAAC World Wide Web pages also offer documentation and technical support for SeaWiFS data, links to the SeaDAS data analysis software site, and current information regarding SeaWiFS data and data access. The DAAC also produces a quarterly newsletter, and will contact the user community as the need arises with pertinent messages.

Moderate Resolution Imaging Spectroradiometer (MODIS)

The Moderate Resolution Imaging Spectroradiometer (MODIS), to be orbited onboard both the EOS-AM satellite (in 1998) and the EOS-PM satellite (in 2000), possesses several features that will make its ocean image data useful for continuing studies of the marine biosphere from daily to decadal scales. Of primary impor-

tance is the capability of the MODIS instrument and data system to obtain a 1 kilometer resolution dataset over the entire global ocean. Optical technology gives MODIS an even better signal-to-noise ratio than SeaWiFS, with extremely narrow bandwidth. Additional bands allow observation of chlorophyll fluorescence, which indicates the physiological state of phytoplankton. MODIS data will allow a more precise determination of chlorophyll concentration and light attenuation due to suspended matter in the water column. MODIS products also include the first routine quantification of light absorbed by phytoplankton and both weekly and annual ocean primary production.

MODIS will also produce several other specific products of interest to the oceanic research community, including marine aerosols in the atmosphere, coccolith concentration, and photosynthetically active radiation. In particular, MODIS will provide global observations of sea surface temperature (both bulk and skin temperature) using split windows in both the 4 micron and 11-12 micron region. This approach will provide additional insight into air-sea heat and moisture fluxes, as well as the influence of temperature variability and basin scale phenomena (such as El Niño/Southern Oscillation) on the marine biosphere.

MODIS Information: http://daac.gsfc.nasa.gov/CAMPAIGN_DOCS/OCDST/modis_info.html

The DAAC will archive all MODIS Level 0 data, and is responsible for the generation and archive of all Level 1 products (approximately 285 GB per day). The Level 2, Level 3, and Level 4 Ocean products are slated for production and archive at the DAAC, which represents a full capacity production rate of 106 GB per day. The DAAC expects to support MODIS ocean data in a manner similar to CZCS and SeaWiFS data.

Instrument Comparison (Wavelengths and Bandwidths)
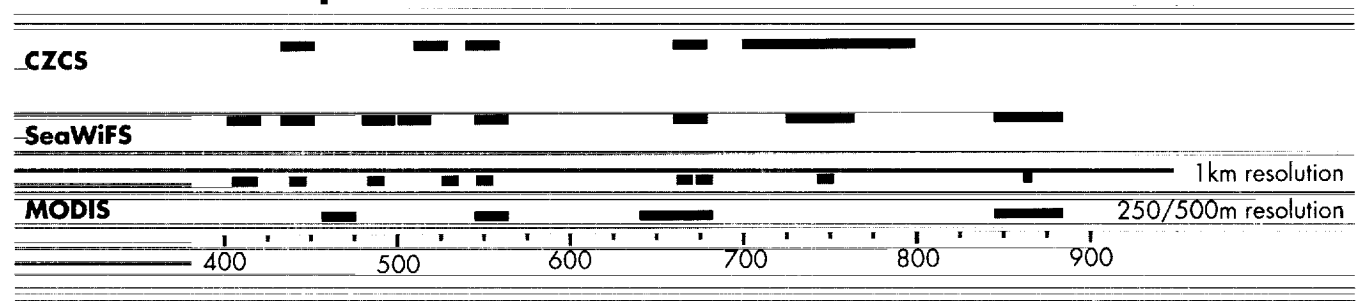
SeaWiFS Data Products

Parameter	Level
Raw radiance counts at 412, 443, 490, 510, 555, 670, 765, 865 nm	1A LAC/GAC
Calibration data	1A LAC/GAC
Navigation data	1A LAC/GAC
Instrument and spacecraft telemetry	1A LAC/GAC
Normalized water-leaving radiances at 412, 443, 490, 510, 555 nm	2,3
Aerosol radiance at 670 nm	2,3
Aerosol radiance at 865 nm	2
Phytoplankton pigment concentration	2,3
Chlorophyll-a concentration	2,3
K(490)	2,3
Chlorophyll-a concentration:K(490)	3
Epsilon of aerosol correction at 765 and 865 nm	2,3
Aerosol optical thickness at 865 nm	2,3

Level	Spatial resolution	Temporal resolution	Data granule	Size
1A	1.13 km (LAC)	one pass	One downlink session	58–70 MB
1A	4.5 km (GAC)	one orbit (98.9 min)	One global (north-to-south) orbital swath	19.1 MB
2	4.5 km	one orbit (98.9 min)	One global (north-to-south) orbital swath	21.9 MB
3	9 km	Daily, Weekly, Monthly, and Annually	12 global equal-area grids, 1 corresponding metadata file	150 MB or 429.1 MB

MODIS Data Products

Parameters	Level
Normalized water leaving radiance at 411, 442, 487, 530, 547, 665, 677 nm	2,3
Tau aerosol, 865 nm	2,3
Epsilon of aerosol correction at 746 and 866 nm	2,3
Aerosol model ID 1,2	2,3
Epsilon for clear water at 530 nm	2,3
CZCS Pigment	2,3
Chlorophyll from MODIS algorithm	2,3
Total pigment - case 1	2,3
Fluorescence line height	2,3
Fluorescence baseline	2,3
Fluorescence efficiency	2,3
Suspended solids concentration	2,3
Pigment concentration in coccolithophore blooms	2,3
Detached coccolith concentration	2,3
Calcite concentration	2,3
Diffuse attenuation coefficient K(490)	2,3
Phycoerythrobilin	2,3
Phycourobilin	2,3
Chlorophyll-a (semianalytic)	2,3
Chlorophyll-a (default)	2,3
Instantaneous Photosynthetically Active Radiation (PAR)	2,3
Absorbed radiation by phytoplankton	2,3
Gelbstoffe absorption coefficient	2,3
Chlorophyll-a absorption coefficient	2,3
Total absorption at 411, 442, 487, 530, 547, 665, 677 nm	2,3
Primary productivity weekly indices	3
Primary productivity index annual average	3
Primary productivity annual high variance - total new, export	3
Sea surface temperature (skin, bulk), Day	2,3
Sea surface temperature (skin,bulk), Day, 4 microns	2,3
Sea surface temperature (skin,bulk), Night	2,3
Sea surface temperature(skin, bulk), Night, 4 microns	2,3

Level	Spatial resolution	Temporal resolution	Size	Volume archived per day
2	1 km	5 min	42–160 MB	12–23 GB
3	4.65 km	Daily, Weekly, Monthly, Annually	620–3,280 MB	310–8,840 MB

The Goddard DAAC Ocean Color Data Support Team on the World Wide Web:

http://daac.gsfc.nasa.gov/CAMPAIGN_DOCS/OCDST/OB_main.html

Email: ocean@daac.gsfc.nasa.gov or daacuso@daac.gsfc.nasa.gov
Phone: (301) 614-5224
Fax: (301) 614-5268